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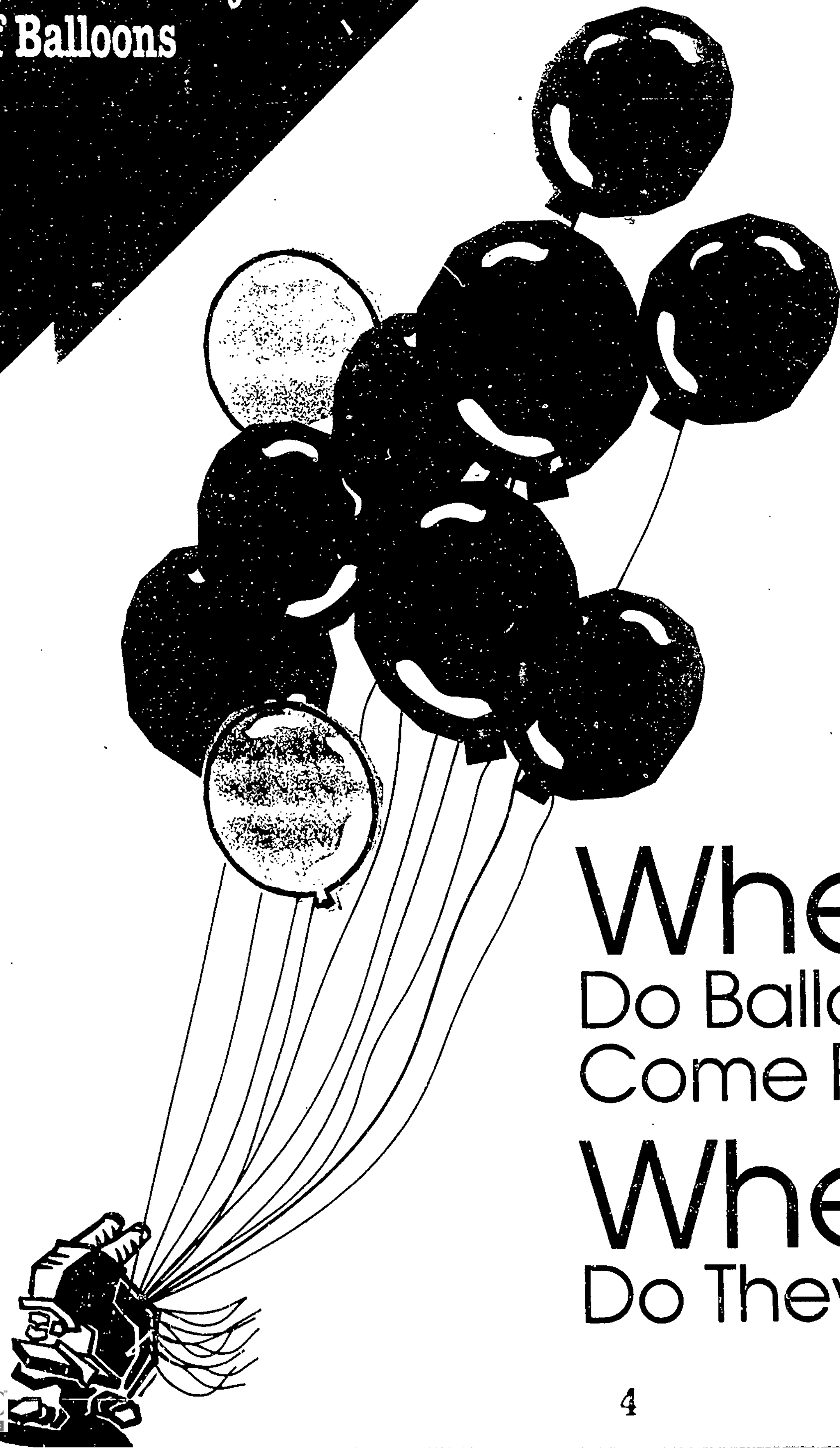
ABSTRACT

This document provides background information on balloons including: (1) the history of balloons; (2) balloon manufacturing; (3) biodegradability; (4) the fate of latex balloons; and (5) the effect of balloons on the rainforest and sea mammals. Also included as part of this instructional kit are four fun experiments that allow students to investigate some of the questions raised in the background information. (ZWH)

THE BALLOON COUNCIL

Balloons And Science Kit

A Brief History of Balloons

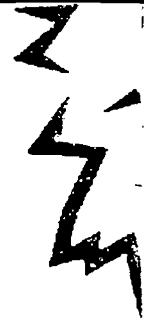


Where Do Balloons Come From? Where Do They Go?

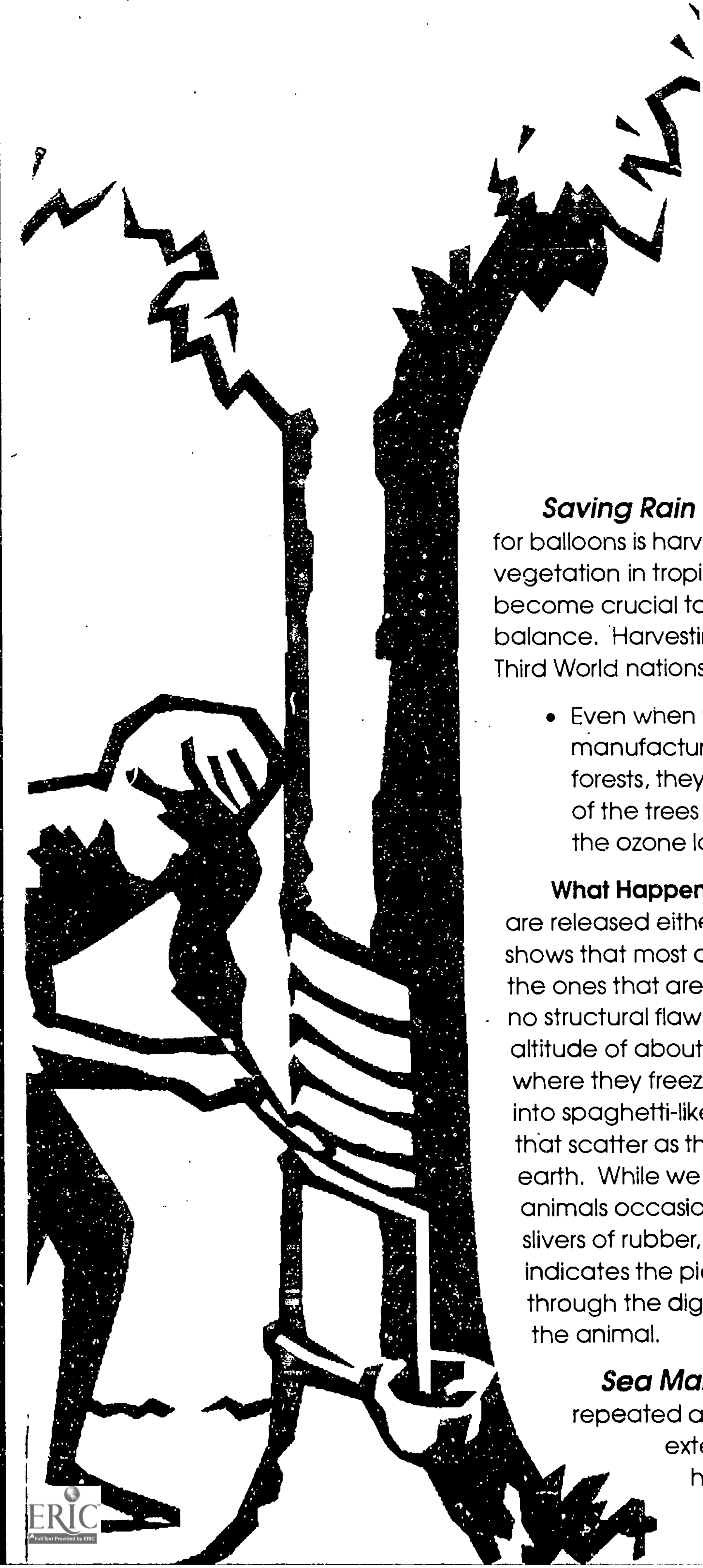
History: Balloons — in one form or another — have been around for centuries. But the modern latex balloon — the kind you can blow up yourself — was invented only a little more than 60 years ago in New England. A chemical engineer, frustrated in his attempts to make inner tubes from this new product — liquid latex — scrawled a cat's head on a piece of cardboard and dipped it in the latex. When it dried, Neil Tillotson had a "cat balloon," complete with ears. He made about 2,000 balloons and sold them on the street during Boston's annual Patriot Day parade. Latex balloons still are made from dipping forms into latex, but the process is mechanized.

- Early balloons were made from pig bladders and later from a rubber similar to that used to make rain boots. Today's latex balloons are 100 percent natural. They are made from a milky substance from rubber trees.
- In the late 1970s, silver metalized balloons were developed for the New York City Ballet. These balloons are commonly called mylar, but they are actually made from a metalized nylon and are more expensive than latex balloons.
- Today, balloons are floating greeting cards. Almost 80 percent are used to deliver messages — from "Happy Birthday" to a proud "Mom, You're the Best."

Balloon Manufacturing: Latex balloons are produced from the milky sap of the rubber tree, *Hevea brasilliensis*. The rubber tree originated in the tropical forests of South America and was taken to Europe from Brazil— hence its Latin name. It is now grown on plantations in many tropical countries. The latex is collected in buckets, as it drips from harmless cuts in the bark. The process is much like that used to collect maple syrup. The use of latex balloons and other products, such as surgical gloves, make rubber trees economically valuable, which discourages people from cutting them down.



Biodegradability: Latex is a 100-percent natural substance that breaks down both in sunlight and water. The degradation process begins almost immediately. Oxidation, the



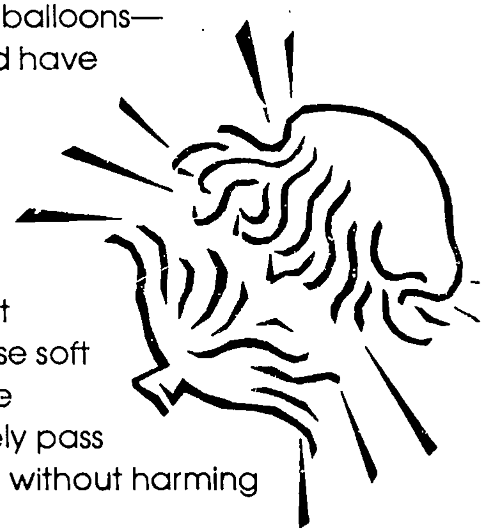
"frosting" that makes latex balloons look as if they are losing their color, is one of the first signs of the process. Exposure to sunlight quickens the process, but natural microorganisms attack natural rubber even in the dark.

- Research shows that under similar environmental conditions, latex balloons will biodegrade at about the same rate as a leaf from an oak tree. The actual total degradation time will vary depending on the precise conditions.

Saving Rain Forests: Rubber trees, from which the latex for balloons is harvested, are one of the main forms of vegetation in tropical rain forests, which in recent years have become crucial to maintaining the earth's fragile ecological balance. Harvesting latex can be more profitable to poor Third World nations than raising cattle on the deforested land.

- Even when the trees producing latex for balloon manufacturing grow on plantations instead of in rain forests, they help the ecosystem, as the natural biology of the trees helps maintain our atmosphere and protect the ozone layer.

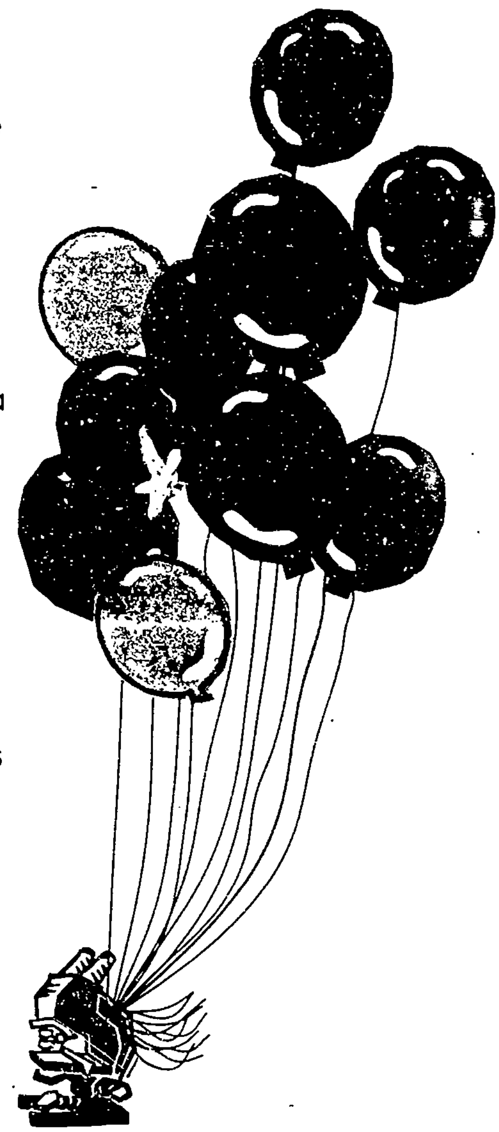
What Happens to Balloons That Fly: Often latex balloons are released either on purpose or accidentally. Research shows that most of these latex balloons—the ones that are well-tied and have no structural flaws—rise to an altitude of about five miles, where they freeze, breaking into spaghetti-like pieces that scatter as they return to earth. While we do know that animals occasionally eat these soft slivers of rubber, the evidence indicates the pieces ultimately pass through the digestive system without harming the animal.



Sea Mammals: Although many stories have been repeated about sea creatures dying from balloons, extensive research by the industry and reporters has yet to verify one such story. In one study of 439 dead sea cows over an 8-year

period, Cathy Beck of the U.S. Fish & Wildlife Service did not find a single balloon inside a single deceased sea cow.

- The most frequently cited case is one in which the Marine Mammal Stranding Center in Brigantine, NJ, found a balloon in the intestinal track of a dead sea turtle. Bob Schoelkopf, the director of the Center, has said himself that the balloon could not be identified as the cause of death.



Litter: Balloons are not a significant litter problem. During a nationwide beach cleanup in 1992, volunteers collected more than 614,433 bottles and cans, but found fewer than 32,000 balloon pieces. These pieces — collected over more than 4,600 miles of shoreline — would fit inside four trash bags.

However, The Balloon Council encourages consumers to dispose of balloons—like all products—properly. We support weights on all helium-filled balloons to keep them from floating away accidentally and ask consumers to put deflated balloons in the proper receptacles. Children under age 8 should always be supervised while playing with latex balloons because of the possibility of their choking on them.

The Balloon Council: Formed in 1990 by manufacturers, distributors, and retailers, the Council has embarked on a nationwide campaign to present the facts about balloons and educate consumers as to their proper use.

"Balloons and Science"

These experiments are designed for elementary school use, to help teach children basic principles of biodegradability, permeability, wind direction, and gases in the atmosphere.

The experiments were developed for The Balloon Council by Dr. Arthur Livermore, a consultant in science education and the former director of education for the American Association for the Advancement of Science. He received his doctorate in biochemistry from the University of Rochester and did postdoctoral research at the Cornell University Medical College. Dr. Livermore has been an education consultant since 1981.

Sandra Geddes, a science teacher with the Montgomery County, Md. public schools, consulted with The Balloon Council on the experiments. She has been an elementary school teacher for more than 25 years.

The "Balloons and Science" kit is made possible by the members of The Balloon Council, with special recognition to Anagram International, Ansell Americas, Balloon Supply of America, Betallic Balloons, Classic Balloon Corporation, CTI Industries, Flowers Inc. Balloons, Hi-Float Company, M&D Balloons, Pioneer Balloon Company and Premium Balloon Accessories.

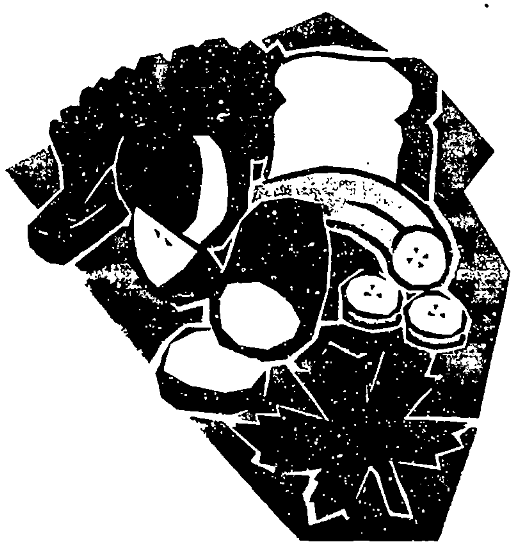
Note: The "starter" balloons in this kit are a much better quality than those used to create the experiments. They will leak air and helium less rapidly and biodegrade more slowly. Biodegrading time can be speeded up by inflating and deflating e balloons before the experiment.

Where Do Balloons Go When They Fall on the Ground?

Rubber latex balloons are degradable because they are a natural plant product. These balloons are made from a milky substance from the rubber tree and decompose by natural processes — exposure to soil bacteria, sunlight, moisture and atmospheric oxygen. Many of your students may be surprised to see just how this happens.

Getting Started

Show the children a collection of natural plant products such as pieces of potato, lettuce, apple, banana, bread and candy. You also can show them things like paper, coffee grounds and tree leaves.



Have the children discuss how these things are different and how they are alike. After a bit, you may want to steer them to the fact that all are natural products by asking, "Where did all these things come from?" Some may say "from the grocery store." But the best answer is: They *grew*.

Discuss what happens to apples, bananas or bread when they "sit around" for a long time. Apples rot. Bananas get soft and turn dark. Bread gets hard and moldy. What about tree leaves? They turn color, fall and gradually decompose. If you can find a leaf skeleton, show it to the class as an example of natural decomposition.

Show the class some latex balloons. Ask whether anyone knows what they are made from. Many may say, "plastic." You can tell them the balloons are natural products, similar to candy. Balloons are made from rubber tree juice. Candy is made from the juice of the sugar cane. Here you can describe how rubber trees are tapped to get the latex.

Now that the class understands that balloons decompose like other natural products, you can ask the students to come up with their own methods of investigation. They should make suggestions for creating experiments to see how balloons decompose. Among the questions they should consider are: location of balloons, effect of moisture, light and temperature on the balloons and length of time it might take for the balloons to break down.

Since most of the students already have been exposed to grow lights, soil and plants from previous lessons, they should reach that conclusion on their own. If not, you can lead them in that direction.

Collecting Data

To demonstrate biodegradability, you will need:

- A plant light. A 150-watt GE "gro & sho" light.
- A shallow pan, aluminum pie plate, or Petri dish.
- Garden soil and peat moss, two centimeters deep.
- About 20 grams of composting agents.

Mix the compost with the garden soil/peat moss. Wet the mixture well. Blow up and cut into pieces several balloons before burying in the mixture.

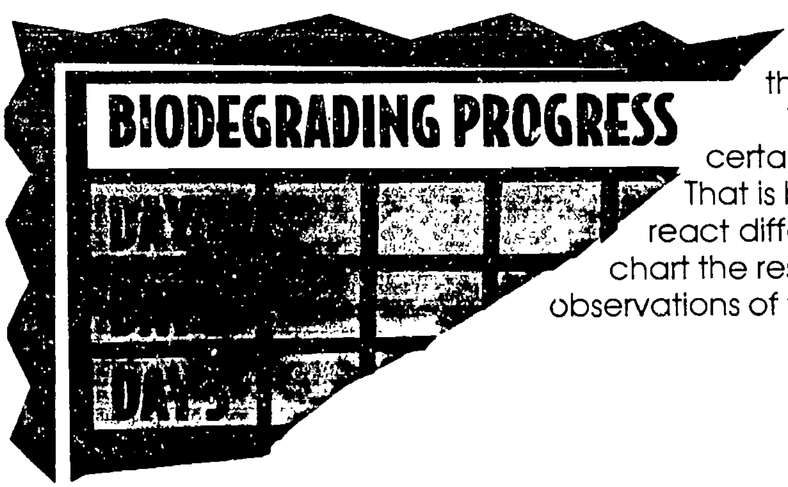
Place the plant light about 20 centimeters (about 8 inches) above the pan. Add water to the pan daily to keep the soil mixture moist.

Explain to the children that bacteria lives in the soil, and that it eats away at the balloon molecules. Ultraviolet light from the sun (represented by the grow light) and oxygen also combine to break down the balloon. The physical appearance of the balloon changes as it decomposes.

Examine the balloons in the pan periodically. After about 20 hours under the light they should begin to show considerable degradation. After 60–70 hours, the balloons should be largely disintegrated. The children can compare the deteriorating balloons to those left in the package in which they came.

Charting Results

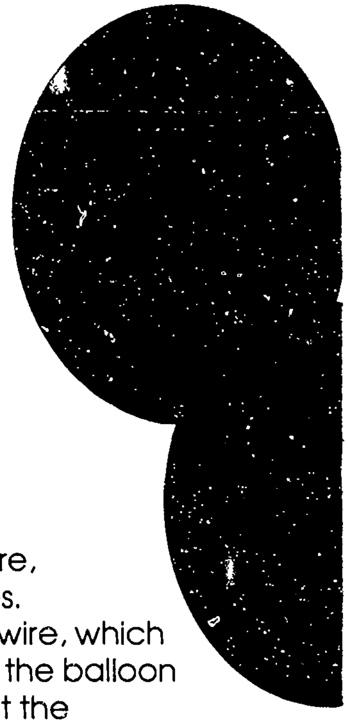
The children may be interested in putting other natural substances in the soil, along with the balloons — such as dry leaves, wood shavings, or grass — to compare the decomposition rates. They also may want to watch balloons break down under other conditions, such as natural sunlight, and compare the different rates of decomposition.



The children might notice that balloons of certain colors biodegrade faster than others. That is because the chemicals in different dyes react differently to the bacteria. Suggest that they chart the results and write a report on their observations of the decomposition process.

Learning About Permeability

EXPERIMENT # 2



In this activity, the children investigate two properties of latex balloons — they stretch and they are "permeable," that is gases such as air and helium can pass slowly through the latex membrane.

Getting Started

You can discuss gases in the atmosphere, composition of gases, atoms and molecules. Inflating a balloon and sticking a long, thin wire, which can be obtained at a flower shop, through the balloon without bursting it can raise questions about the composition of natural products and molecules. Inflating the balloons can be accomplished safely with an inexpensive hand inflator sold for about $5 at gift and card shops.

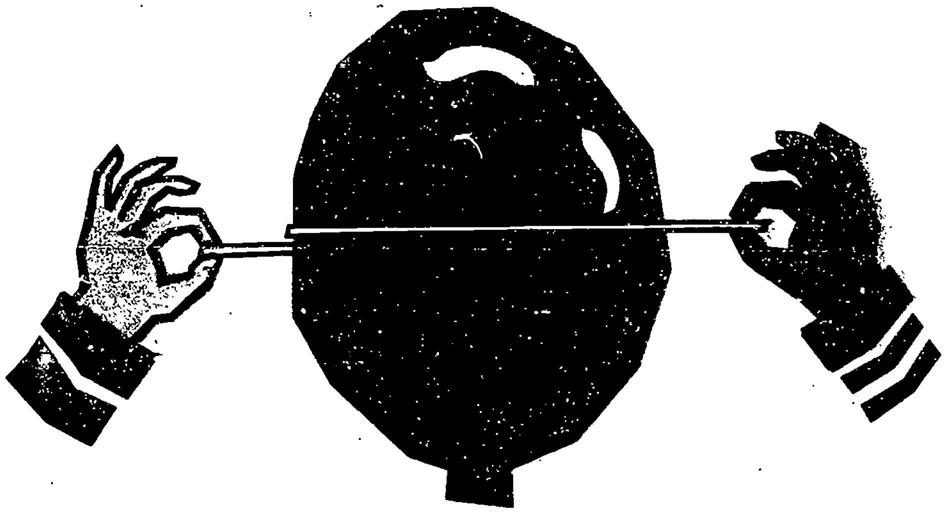
Collecting Data

Balloons Stretch. Children can work in pairs. One will inflate the balloon, the other will measure the circumference with string. The length of the string that fits snugly around the balloon is the circumference. Children can measure the length on a yardstick or meter stick.

The teams can inflate their balloons until they burst. Have each team record the length of the circumference when its balloon bursts. Were the bursting circumferences all alike? If not, ask the children to discuss why they think some burst at a smaller size than others.

Balloons Leak. You can start this activity by blowing up a balloon until it is well-inflated. Close it by tying a knot in the neck or by tying it tightly with string. Show the balloon to the class and ask whether the balloon will stay this size. There will probably be a difference of opinion. Tell them that they can find out whether or not inflated balloons stay the same size by measuring the circumferences with string as they did in the earlier experiment.

Give small groups of children balloons and have them inflate them, tie them off and measure and record the



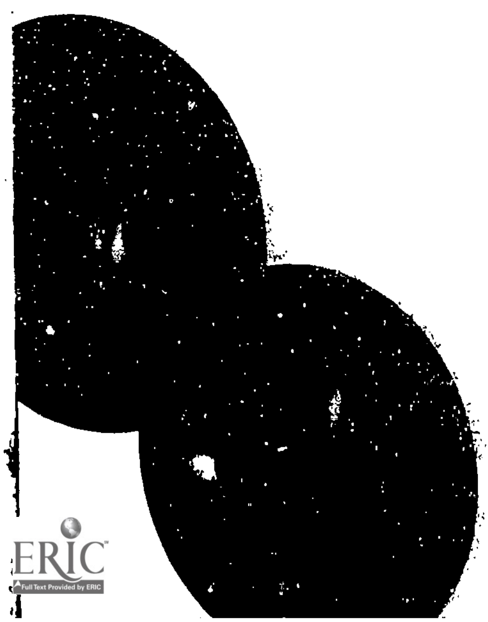
circumferences. Have them make measurements several times during the first day and then daily until the balloons have deflated significantly. Ask, "Where did the air go?" You can tell the children that even though they cannot see holes in the balloon, there are very, very tiny ones that let the air escape.

Next, use helium to compare the difference between the two gases. Have the students compare the rate of escape of helium from balloons with the rate of escape of air. Be sure to use the same kind of balloons, inflated to the same size (circumference.) Measure the circumference at intervals as the balloons get smaller and record the time and circumference.

Since obtaining a helium tank can be expensive, most card and gift shops will inflate balloons with helium for a few dollars. You can bring pre-inflated balloons to class to conduct the experiment.

Charting Results

The children probably will find that the helium-filled balloons get smaller faster than the air-filled ones. Ask them to write about their observations and explain why this happens. The explanation is that particles (atoms) of helium are smaller than the particles (molecules of oxygen and nitrogen) of air and so can pass through the very tiny holes in the rubber more easily.



Measuring How Fast Helium-Filled Balloons Rise

EXPERIMENT #3

This activity is designed for the classroom. Helium-filled latex balloons should have lengths of light thread attached, long enough to reach from the floor to the ceiling. (Balloons can be filled with helium inexpensively at card and gift shops the afternoon before you plan to do the experiment.)

Getting Started

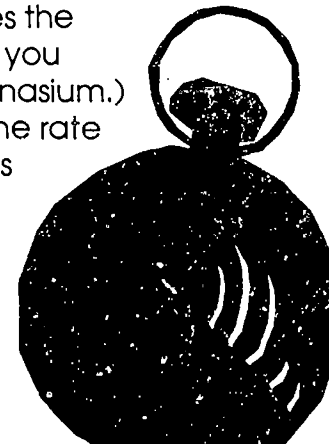
Show the class a helium-filled balloon and let it go so it rises to the ceiling. The activity raises questions about why the balloon rises, how fast it goes up and when it will come down. Let the children discuss the questions and propose experiments to test the concepts of gases in the atmosphere. You can suggest the following activity.

Measuring Rate of Rise. Give each group of children a helium-filled balloon. Each group should have one child who calls out the time of release and the time the balloon reaches the ceiling; a child who releases the balloon on signal; a child who counts down "3, 2, 1, Go," and children who call "now" when the balloon reaches the ceiling.

Time can be measured with a clock or watch with a sweep second hand, a digital clock that measures seconds or a stopwatch.

Have one group demonstrate how to hold the balloon at floor level, release it, and measure and record the release time and the time it reaches the ceiling. (If your room has a low ceiling, you may want to do this activity in the gymnasium.)

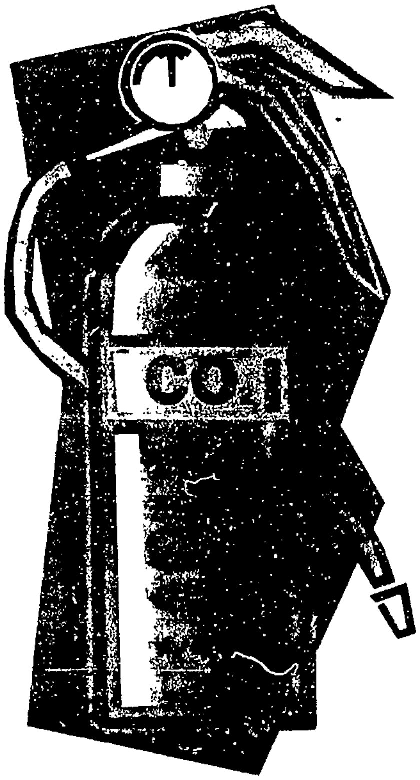
Now, have each group measure the rate of rise of its balloon. Did all the balloons rise at the same rate? Have the children suggest explanations.



Changing Rate of Rise. Helium-filled balloons gradually lose helium, as the children observed in the permeability experiment. Have them measure the

rate the balloons rise as they get smaller — and record the circumference each time.

Adding weights will change the rate of rise. The children can attach large paper clips to the string at the neck of the balloon and measure the rate of rise with 1, 2 or 3 clips. How many clips does it take to make the balloon float level — neither rising or falling?



What Happens to Balloons that Keep Rising. If a helium-filled balloon floats away outdoors, what happens to it? Balloons rise into the atmosphere where the pressure and temperature decrease with altitude. Data from the National Weather Service show that at a height of five miles and air temperature of minus-40 degrees F balloons blow apart into small pieces. The natural rubber actually shatters due to the combination of high pressure and cold.

When the balloon bursts at the five-mile altitude, the balloon ends up as tiny spaghetti-shaped slivers of latex. Although it is impossible to recreate this process exactly, the shattering of helium-filled balloons can be simulated in the classroom by using a CO_2 fire extinguisher. The CO_2 inflates the balloon at a much lower temperature than helium and when it reaches the bursting point, shatters most of the balloon into thin strips of latex.

To demonstrate this, you or a group of students can attach the balloon over the nozzle of the CO_2 tank, press the handle and when the balloon inflates to its bursting point, it blows apart. The balloon can shatter with some force, so it's important to stand behind the fire extinguisher. If they are available, students can wear safety goggles during the experiment.

Which Way Is the Wind Blowing?

EXPERIMENT #4

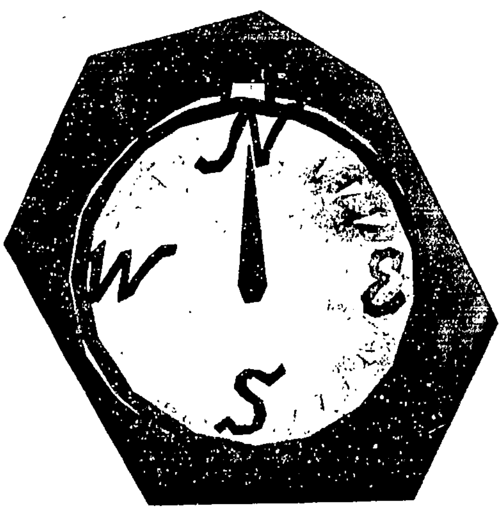
Children can use helium-filled balloons to observe wind direction. They use a magnetic compass to measure direction. A magnetic compass measures the earth's magnetic north, which is slightly different than the true north directly below the North Star. They will see that even a "steady" wind changes direction frequently and that it also changes its speed.

Getting Started

On the playground or from the classroom window, call the children's attention to the wind. How can we tell it is blowing? (From the classroom by watching leaves, branches or flags move. Outside you also can feel it.)

Which way is the wind blowing? What do we mean by "which way"? (From and to some compass direction. From the west and to the east, for example.) How could we measure the direction? (Use a magnetic compass.)

Collecting Data



Wind Direction. This experiment is done outside either with the entire class using one balloon or with children in groups, each group having a balloon.

Tie the helium-filled balloon to a string — 20 to 50 feet long. Choose a site where the balloons will not get entangled on nearby objects. Tie a loop in one end of the string so it is easy to hold — or tether it to a heavy object such as a hammer on the ground or a fence.

Have the students observe and comment on the fact that (assuming the wind is blowing) the string does not go straight up, but inclines at an angle away from the wind.

Have several children measure the direction the string inclines — that is, the direction the wind is blowing — with a magnetic compass. The children may need instruction on how to use a compass to measure directions. For example, they will need to know that the compass needle points north and when they hold the compass to measure a direction, they should hold it so that the N is at the end of the needle. To observe the correct direction, the compass

must be held at a place where the balloon appears to be vertically above the tether point — that is, directly upwind.

Have the children record the wind direction as a compass reading. They then can make a map of the experiment site, using arrows to show wind direction.

Changes in Wind Direction. The wind does not often blow steadily from one direction. Usually, it wobbles back and forth a few degrees. If it does when you are doing your experiment, have the children try to measure how big the wobble is. Have them record the directions they observe. Then they can make a map of the observation site, using arrows to show the different wind directions.

Extensions. You may want the children to try other ways to demonstrate wind direction such as observing weather vanes, blowing soap bubbles and flying kites.

Charting Results

In addition to all of the charts and observations the students have made conducting the experiment, ask them to compare theirs to other students' work. Show them the map below. It records wind directions observed by student teams using the methods of this experiment. Measurements were made April 24, 1989, as part of a national weather experiment. Have the children note that the wind blows in different directions at the various sites.

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